Exhibit E

2024

Rebuttal Expert Report

RIVER TRAINING STRUCTURES AND OTHER METHODS TO REASONABLY IMPROVE THE NAVIGABILITY OF THE RIO GRANDE BETWEEN RIVER MILES 275.5 AND 610.0

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1. Summary of Opinions

- After reviewing Ancil Taylor's, Shields, Magers/Hart, Ciarametaro, and Rubenstein/Settemeyer expert reports on reasonable improvements to the Rio Grande downstream of Amistad Reservoir, I agree that a system of locks and dams between Del Rio Texas (river mile 610) and Laredo Texas (river mile 275.5) would improve navigation in this reach.
- After reviewing Dr. Shields' expert report on reasonable improvements to the Rio Grande downstream of Amistad Reservoir, I agree that there is insufficient water to support an open river 9-foot deep by 250 feet wide[1] navigation channel between Del Rio Texas and Laredo Texas for 365 days of the year. I disagree that there is insufficient water for a system of locks and dams.
- After reviewing Christine Magers and Cassandra Hart's expert report on environmental resources and impact review, I find there are numerous errors and omissions and a disregard for consideration for the full range of river navigation improvement methods in their assumptions. For this reason, I question the veracity and applicability of the remainder of their report.
- An open river navigation channel on the Rio Grande of dimensions less than 9-feet deep by 250 feet wide (9'x250') is feasible and compliments the hydrology and topography of the Rio Grande better than a 9'x250' wide navigation channel.
- An open river navigation channel on the Rio Grande that operates for a portion of the year (navigation season) is feasible and compliments the hydrology of the Rio Grande better than a channel that operates 365 days of the year.
- After reviewing Dr. Shields' expert report on reasonable improvements to the Rio Grande downstream of Amistad Reservoir, I disagree that there is insufficient water to support a system of locks and dams as proposed by Ancil Taylor. Dr. Shields overestimates water loses due to evaporation and lockages and makes assumptions that are not supported by Ancil Taylor's proposal, or the topography of the river's floodplain and watershed.
- Ancil Taylor has extensive experience in dredging but is not a professional engineer and has no or very limited experience in the design, construction, or evaluation of locks and dams or methods other than dredging to improve a river for navigation. Due to this lack of experience, Ancil Taylor is not qualified to provide opinions on methods other than dredging to improve a river for navigation.
- Dr. Shields has extensive experience in the study and evaluation of the environmental aspect of river engineering and topics "intrinsic" (his word) to river engineering but has very limited to no experience in the design, construction, or evaluation of methods to improve a river for navigation. Due to his lack of experience, Dr. Shields is not qualified to provide opinions on methods to improve a river for navigation.
- Dr. Shields and Mr. Taylor have no experience conducting studies on the need, feasibility, politics, or economic justification of navigation improvement projects. Nor have they provided even a cursory analysis of such. For these reasons, Dr. Shields and Ancil Taylor are not qualified to provide opinions if a navigation improvement project is a desirable public works project. Their lack of experience on small navigation improvement projects is especially germane considering

[1] Dr. Shields references a 250-foot wide channel in his report but uses 300 feet as the modeled width to calculate flow requirements.

they are proposing large and extremely costly options for improvement to navigation on the Rio Grande. Navigation studies are complex, costly, and take significant resources. Without such studies and due to their lack of experience in such studies, they are not qualified to offer opinions on their proposals.

- Dr. Shields and Mr. Taylor have never participated in a River and Harbors Act Section 10 permit application that involves National Environmental Policy Act (NEPA) documentation wherein the effects of a proposed project on the human environment are evaluated and disclosed, or evaluated the application for impacts to navigation. Nor have they conducted even a cursory NEPA analysis, or navigation impacts analysis, of the navigation improvements they evaluated. For this reason, they are not in a position to opine opposition to a project of the large magnitude they propose.
- Dr. Shields and Mr. Taylor only consider navigation improvements that are grandiose in scale and therefore present an all or nothing choice. They do not consider incremental improvements that are localized or systemwide but smaller in scale, or improvements that are scalable to the needs of the basin. They do not consider the incremental improvements proposed by Timothy MacAllister.
- Mr. Ciarametaro offers opinions on the challenges and feasibility of improving the Rio Grande for navigation and offers that locks and dams are the only viable option. Mr. Ciarametaro has very limited to no experience in the planning, design, feasibility study, or construction of any navigation project and is unqualified to offer opinions on such.
- Mr. Rubinstein and Mr. Herman Settemeyer offer opinions that there are only two methods to improve navigation on the Rio Grande. Although very knowledgeable on water uses and rights, neither of these gentlemen have experience in the planning, design, feasibility study, or construction of any navigation project, nor have they conducted any analysis, and are unqualified to offer opinions on such.
- Ms. Magers and Ms. Hart examine a very limited range of river improvement options in their report. They do not cover river improvement options covered in this report or Mr. MacAllister's report and therefore their report is limited in the evaluation of the full range of options in navigation improvement method. This is a serious defect in their report.
- There are numerous simple, inexpensive, and scalable methods that can be undertaken to incrementally improve navigation on the Rio Grande including: curtailment of flows at Maverick Powerhouse when flows in the Rio Grande are low, removal of portions of rock shelfs present in the river at discrete locations, construction of a limited number of River Training Structures (RTS) at selected locations, and/or channel realignments at locations with sharp bends. These methods are covered in this report and some of these methods were covered in Mr. MacAllister's report.
- The Rio Grande between Del Rio Texas and Laredo Texas, roughly river miles 610 and 275.5 respectively, can be systematically improved for navigation by the construction of a full suite of RTS. RTS are simple and inexpensive to construct, require little maintenance, are scalable to the desired end result (a few structures can be built to achieve incremental improvements or a full suite of structures built to a achieve a reliable channel over a range of flows), and can be easily modified after construction if the desired effect is not achieved. RTS can be constructed using commonly available land-based construction equipment with stone quarried from local quarries and hauled by truck to the river.

- The release schedule of Amistad Reservoir could be altered to ensure adequate navigation releases during a predetermined 'navigation season'. The navigation season does not need to be 365 days of the year. The release schedule alteration would balance length of season verse rate of flow for desired depth in the navigation channel. In other words, since there is only so much water in the system, a shorter season will allow for higher releases and greater depths in the navigation channel while a longer season would require lower releases resulting in less depth.
- Based on current flows at Eagle Pass Texas, and with a full suite of constructed RTS, a navigable channel 8-months of the year, 130 feet wide, and 6 feet deep will only require 54% of the average annual flow at Laredo. Other depths and season lengths were calculated that show there is sufficient water in the system for a navigation channel.
- A full suite of river training structures and other improvements for the reach examined in this report would cost approximately $2.7 Billion, while improvements smaller in scale and localized could be undertaken for a fraction of this amount.
- My opinions are based on my 29 years of experience as a hydraulic engineer, review of plaintiff and defendants Expert Reports, observation of the physical nature of the Rio Grande River during a site visit to Eagle Pass, review of the physical nature of the Rio Grande River and floodplain using aerial photography, and my experience designing, constructing, and monitoring the effects of RTS on rivers similar to the Rio Grande.

2. Qualifications

I am Michael D Chapman, Senior Technical Lead for the Kansas City District of the U.S. Army Corps of Engineers (USACE). I have been employed with the Kanas City District for over 31 years with 29 of those years as a hydraulic engineer involved in river-based District projects. I have held my current position since July 2020 and my duties include providing technical guidance to Program Managers and Product Delivery Teams for the execution of a one-time $300,000,000 funding allocation for the repair and improvement of 500 river miles of the Missouri River Bank Stabilization and Navigation Project (BSNP) on the Missouri River. Specifically, I developed a detailed execution plan for Program Managers outlining the best allocation of funds between various BSNP needs and worked closely with Product Delivery Teams developing contract plans and specifications for project execution. Contracts executed under this one-time funding allocation included large contracts to repair existing river training structures (RTS), construct new RTS, removal of old bridge piers, removal of bedrock outcrops, modification of chute closure structures, and removal of tributary sediment debris deltas. Prior to my current assignment I served as Supervisor of the River Engineering and Restoration Section since 2003 (between 2003 and 2007 the Section was a Unit). In this capacity I supervised a team of engineers and technicians engaged in the execution of river-based projects within the Kansas City District. Section tasks included: hydrographic and topographic data collection, geospatial analysis of data and information, mapping, 1-dimensional and 2-dimensional numeric modeling of river systems, design of RTS on various streams, on-going maintenance program for over 5,000 RTS of the BSNP, design of new RTS to improve navigation on the BSNP, design and monitoring of navigation channel dredging, design and modification of new and existing RTS for aquatic habitat improvement on the BSNP to comply with Endangered Species Act requirements, sediment studies on the BSNP and other rivers, monitoring repair and construction of RTS, monitoring the geomorphic effect of RTS, participation in feasibility studies examining navigation improvements and alternatives, technical analysis of various Rivers and Harbors Act of 1899 Section 14

(408) permits including commercial sand and gravel dredging on the Missouri River, technical analysis and guidance to the District Regulatory Office for Rivers and Harbors Act of 1899 Section 10 permits on various streams to include sand and gravel dredging on the Missouri and Kansas Rivers. Coordination with federal and state agencies on endangered species and aquatic habitat issues on District riverine projects, and other tasks inherent in the management of rivers.

Prior to my role as a Supervisor, I served as a Project Engineer for operation and maintenance of the BSNP. Duties included repair prioritization and execution of repair contracts for BSNP RTS, field inspections, navigation channel dredging, engagement with the navigation industry to identify and improve navigation problem areas, and engagement with federal and state agencies on methods to minimize adverse environmental impacts of the BSNP.

In these roles my personal opinions concerning the value to the nation of the projects I worked on did not influence the execution of my duties and I faithfully expended all funds appropriated by Congress in a manner that provided the best value to the nation.

A rough estimate of the value of river-based contracts that I have worked on over the last 29 years is approximately $700,000,000 and includes hundreds of new RTS and thousands of modifications to existing structures.

Other related duties included knowledge sharing of riverine navigation with the country of Brazil during a two month in-country detail focused on navigation improvements to the Sao Francisco River and as an instructor for an in-country class titled 'Design and Construction of River Training Structures'. I also actively engaged in the Corps' 'River Engineering Community of Practice' which includes almost all engineers within the Corps engaged in river-based projects. In this capacity I have exchanged professional knowledge with other engineers engaged in river engineering and in the operation and maintenance of navigation channels.

I am a licensed Professional Engineer in the State of Missouri.

- BS, 1993, Civil Engineering, University of Missouri-Kansas City, 5100 Rockhill Road, KCMO, 64110

- BS, 1983, Agriculture-Horticulture, University of Missouri-Columbia, Columbia, Missouri, 65211

3. Site Visit to the Rio Grande and other Observations

On June 4, 2024, I participated in a site visit of the Rio Grande in the vicinity of Eagle Pass, Texas. The site visit was hosted by the Customs and Border Protection, Border Patrol (CBP) in a small vessel. The reach of the river inspected extended from approximately 1 mile downstream of the railroad bridge at Eagle Pass to the Maverick Powerplant located approximately 10 miles upstream of the city limits of Eagle Pass. The two CBP agents assigned to the boat were very knowledgeable of that reach of the river and were able to follow the thalweg (deepest part of the river) as we progressed upstream and downstream. According to the CBP agents, the flow in the river on the day of inspection was approximately 2,000 cubic feet per second (cfs) at Eagle Pass, Texas, which is a flow that occurs more than 25% of the time but less than 75% of the time (Adrian Cortez, Figure 10, page 28). The boat was equipped with an electronic depth sounder (colloquially referred to as a 'fish finder'). Depths were noted to range from 2-feet to about 9-feet.

Observations include, but are not limited to:

a. The Rio Grande appears to be fairly stable in the inspected reach as evidenced by a small percentage of the banks showing a minor amount of erosion (Figure 1). This field observation was augmented with a review of time series of aerial photos at selected locations in Google Earth Pro. The review indicated the river is essentially unchanged in location since the early 1990s. However, banks at some locations on both sides of the river showed signs of active erosion and sloughing which indicates the river is not entirely stable at all locations.

Figure 1: A bank in the inspected portion of the river showing classic signs of bank instability known as sloughing.

b. The river followed a pattern typical of rivers flowing through a bed and banks composed of sands and gravels in that the thalweg shifted from one side of the river to the other side as we moved upstream or downstream and the thalweg was deep in bends and shallower between bends as the river transitioned from side-to-side in channel crossings.

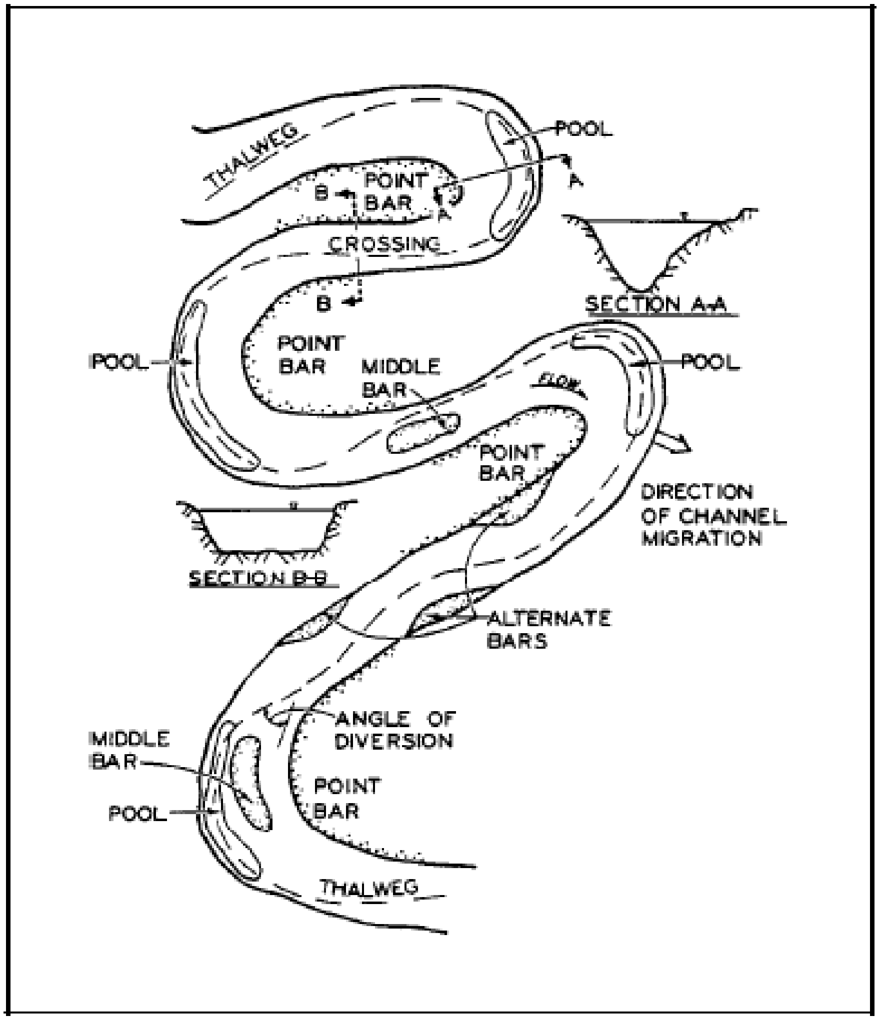

Figure 2: Idealized schematic of a river as it meanders within its floodplain. From EM 1110-2-1611, page 7-7

c. The river frequently divided into two or more channels (split channel) separated by an island. One of the channels was the 'main channel' while the other channel is what is termed a 'side channel chute'. Flow in the river split between the main channel and the side channel chute with most of the flow in the main channel (Figure 3).

Figure 3: An example of a split channel common on the Rio Grande. Island located approximately 7 miles upstream from Camino Real Bridge at Eagle Pass.

d. There were areas of natural rock in the bed of the river that created 'shoals' where the water flowed over the rock with quite a bit of turbulence (Figure 4). It was noted that similar rock existed in the banks at a slightly higher elevation at most of these locations (Figure 5). The rock was less than 3 feet thick and underlaid with sands and gravels. This indicated that the rock in the rapids was likely less than 3 feet thick and rested on sands and gravels, and thus could be easily removed with commonly available equipment.

Figure 4: Picture of one of the more pronounced rock shoals observed during site inspection. Rock appeared similar in composition and thickness to rock observed in banks. Photo taken during site inspection. Approximately 5 miles upstream of Camino Real Bridge.

Figure 5: Typical rock shelf in bank of river near locations of rock shoals in river. Rock layer is approximately 3 feet thick. Photo taken during site visit approximately 4 miles upstream of Camino Real Bridge on left descending bank.

e. A review of aerial photos in Google Earth Pro showed numerous sand and gravel mines in the floodplain next to the river (Figure 6). These pit mines are likely owned by private companies engaged in the business of mining and selling the sand and gravel that has been deposited in the river's floodplain over geologic time. Material from pit mines can also be used for fill material

for projects like roadways, levees, and building foundations. Sand and gravel mines located in a river's floodplain generally contain a layer of sand and gravel between 40 feet and 100 feet above bedrock. From this observation, it is deduced that the bed of the Rio Grande itself rests in a deposit of sand and gravel at least 20 feet thick above bedrock.

It should be noted that Ancil Taylor assumed that the material in the bed and floodplain was vuggy limestone and caliche (Taylor, p. 17). While I agree that there is some vuggy limestone in the bed and floodplain as shown in Figure 5, rivers typically flow through a valley filled to some degree with alluvial material which is loose sand and gravels. The presence of pit mines in the floodplain and my observation of the composition of the bed and banks during the site inspection strongly suggests that the bed and floodplain are filled with sand and gravel, not caliche as Mr. Taylor suggests.

Figure 6: Aerial photo of an area of the floodplain of the Rio Grande on the Mexican Side. Photo on left is dated 2005 and photo on right is dated 2024. Photos show the lake left behind after completion of pit mining. From Google Earth.

4. Assumptions

Since a comprehensive analysis is outside the scope of this report, it was necessary to make some assumptions regarding the nature of the Rio Grande's riverbed and floodplain. The following assumptions are based on my 29 years of river engineering experience, review of aerial photos, observations during my site visit, and a review of assumptions and data in defendants' and plaintiff's expert reports.

a. As discussed above, and lacking any data or claims to the contrary, it is assumed the bed of the Rio Grande rests on at least 20 feet of sand and gravel deposits and that these deposits can be mobilized by the river during high flow events. If this assumption is not correct and the bed rests on a layer of sand and gravel only a few feet thick, the effect of the RTS on the river discussed below will be more limited, but not eliminated. If in fact the bed of the river is

bedrock, unlikely for a river like the Rio Grande, the effect of RTS will be minimal and more localized.

b. Rivers generally only change characteristics when the slope changes, when large tributaries or a large number of smaller tributaries enter, or where the composition and shape of the surrounding watershed changes. Since no large tributaries enter the river in this reach and the river is below the deeply incised upstream canyons and well above the delta at the mouth where the gradient of the river is relatively flat, and the watershed appears homogeneous, it is assumed the Rio Grande from Del Rio to Laredo Texas has physical characteristics similar to the inspected reach near Eagle Pass.

c. Del Rio and Laredo are high population areas that can utilize improvements to increased navigability of the river. Both locations contain low elevation dams that will adversely impact navigability. Therefore, the reach of the Rio Grande discussed in this report extends from the low head dam at Del Rio to the low head dam at Laredo.

5. Review of Ancil Taylor and Dr. Shields Qualifications

Expert Report of Ancil Taylor: Mr. Taylor is not a licensed engineer and does not have a degree in engineering. Mr. Taylor has extensive experience in dredging along the coasts of the United States as well as large inland lakes, but he has no experience designing, constructing, monitoring, or maintaining navigation channels in the nation's rivers. He has no experience designing, constructing, or maintaining locks and dams or designing, constructing, maintaining river training structures or any other navigation channel improvement methods. Mr. Taylor has no experience conducting feasibility studies pertaining to river navigation improvement projects or preparing National Environmental Policy Act (NEPA) documents related to river navigation improvement projects. Mr. Taylor has no experience in the preparation of 'Operation and Maintenance Manuals' for any navigation project. As a result of his lack of experience and lack of education as an engineer, I do not believe that Mr. Taylor is qualified to opine about the design, feasibility, or economic and social costs of any method to improve a river for navigation either incrementally or systemwide. Mr. Taylor only considers locks and dams and does not consider any other method to improve navigation. This is a serious limitation of his report.

I do commend Mr. Taylor for his methodology and resourcefulness given the limited amount of data available. Especially his use of Google Earth Pro to obtain elevations and his use of that data. I believe if Mr. Taylor had experience designing and constructing locks and dams his cost estimate would be lower. Also, he included a cost for pump stations to return lockage water, which as discussed below, is not needed. His unit price for slope protection is 2.5 to 4 times higher than the unit price for slope protection on the Missouri River. And his dredging estimate includes 3 feet of over-depth dredging which is about 2 feet greater than Corps practices.

Expert Report of F. Douglas Shields: Dr. Shields has a Ph.D in engineering and is a licensed engineer. Dr. Shields has worked on a wide variety of river engineering studies related to navigation projects such as the environmental aspects of dredged material disposal and the environmental aspects of river training structures. He has also worked on topics such as riverbank erosion and the role of wood and vegetation in rivers. But, Dr. Shields has no experience designing, constructing, or maintaining river

training structures or any other navigation channel improvement method, and has no experience conducting feasibility studies pertaining to river navigation projects or preparing National Environmental Policy Act (NEPA) documents related to river navigation projects. Dr. Shields has no experience in the preparation of Operation and Maintenance Manuals for any navigation project. As a result of his lack of experience, I do not believe that Dr. Shields is qualified to opine about the design, feasibility, economic and social costs of any method or cost estimate to improve a river for navigation.

I find an error in one of Dr. Shields key calculations. Dr. Shields calculates water losses for a system of locks and dams (Shields, page 17-19). He states, "Lockage and evaporation would require 99% of the flow at Laredo for dry years (10 percentile of annual flow)".

As part of his calculation, Dr. Shields looks at lockage water requirements (Shields, page 15). He states that typical lockage transit time is "45-90 minutes" and assumes 25 lockages per day. He then states that during the driest 10% of years lockage would require more than 27% of the flow in the river. Considering his stated range of lockage times and assuming no lock can be 100% efficient if for no other reason than boats do not queue up at perfect time intervals, I believe a more realistic number of lockages per day to be 16 (90 minutes per lockage). From Table 5 of Dr. Shields report, 16 lockages per day requires 17.5% of the 10th percentile annual flow at Laredo.

In Table 6 Dr. Shields then calculates evaporative water losses for water surface area increases due to the construction of locks and dams and compares the losses to the 10th percentile of flow[2] at Laredo. Dr. Shields calculates evaporative water losses for a range of assumed widths due to locks and dams (Table 6). Dr. Shields does not state what increase factor he used to arrive at his statement that "Lockage and evaporation would require 99% of the water….". However, if we subtract his stated 27% for lockage water needs from the 99%, we arrive at 72% due to evaporative losses. Comparing this value to Table 6 shows that a surface area increase factor of 5 corresponds to 71.7% of the 10th percentile of flows at Laredo. A factor of 5 means the width of the river would increase to 1,800 feet over its entire length[3]. However, the width of the river upstream of a lock and dam diminishes in width as the river rises in elevation. This is similar to the decreasing width of Falcon Lake in the upstream direction (Figure 7). For reference, Falcon Lake has a pool height of 100 feet (Taylor, page 14) above the river immediately downstream.

[2] 10th percentile means that flows are greater 90% of the time and 25th percentile means that flows are greater 75% of the time.

[3] Dr. Shields assumes an existing river width of 300 feet.

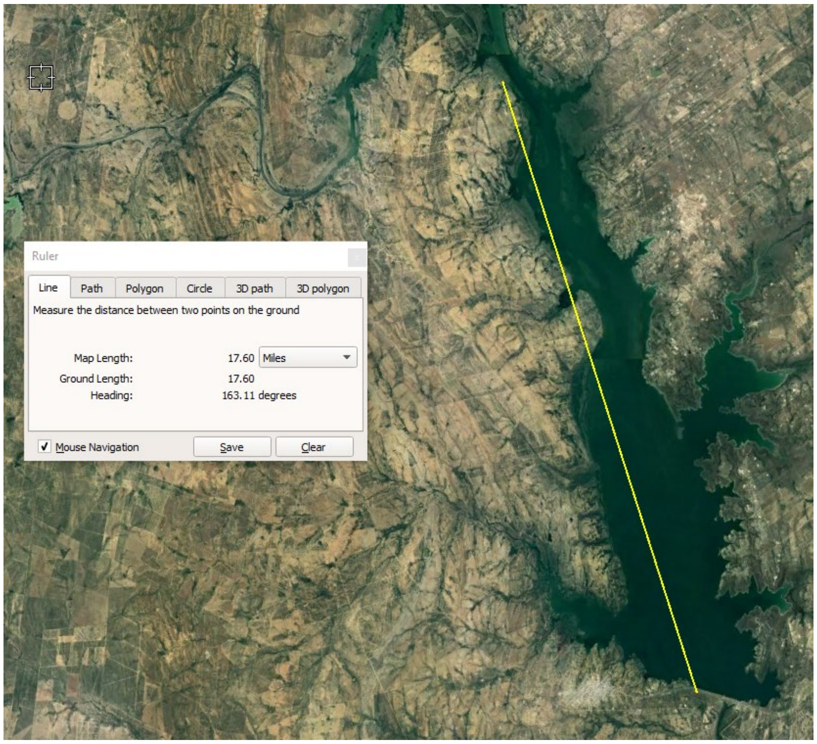

Figure 7: Width of Falcon Lake over 17.6 miles

A review of transect profiles in Google Earth Pro (Appendix D for examples) indicates that 1,200 feet is about the maximum inundated width if a lock and dam raised the water surface 20 feet as proposed by Taylor (Taylor, page 14). Considering 1,200 feet is the maximum width, an increase factor of 3 is more realistic. Since the width decreases in the upstream direction[4], the maximum increase factor of 3 should be cut in half. From Table 6, interpolating for a factor of 1.5, evaporative losses would equal 40% of the 10th percentile of flow at Laredo.

Adding the above evaporative and lockage water losses, the total worse case water need is 40% plus 17.5% or 57.5% of the 10th percentile of flows at Laredo. This indicates that there is sufficient water in the system to account for lockage and evaporative water losses more than 90% of the time (with water left over for consumptive uses) and that water supply is not a limiting factor for the proposed system of locks and dams. This result disagrees with Dr. Shields statement that “the amount of water needed to address losses due to evaporation and lock operation would be prohibitive” (Shields page 18).

6. Review of Ciarametaro, Rubenstein & Settemeyer, Magers and Hart Reports

Expert Report of Thomas P. Ciarametaro: Mr. Ciarametaro is not an engineer or an economist, has no training in these areas, and has very limited to no experience designing, constructing, or maintaining locks and dams, river training structures, or any navigation channel improvement method. Mr.

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[4] Ancil Taylor anticipated this decrease in width in his dredging calculations. He only proposes dredging in the upper reach of each lock and dam pool since his selected lock and dam height alone did not provide sufficient depths in the entire pool. As the pool depth decreases so does the width.

Ciarametaro has no experience conducting feasibility studies pertaining to river navigation improvement projects or preparing National Environmental Policy Act (NEPA) documents related to river navigation improvement projects. Mr. Ciarametaro has no experience in the preparation of Operation and Maintenance Manuals for any navigation improvement project. Due to his lack of training and experience Mr. Ciarametaro is not qualified to render opinions on the following subjects:

a. Ciarametaro Opinion #1: Determination whether the Rio Grande "meet[s] the criteria of a navigable waterway conducive to commercial navigation" (Ciarametaro, page 4 and pages 21-24). Based on my 29 years of experience which includes working directly with the navigation industry and with river engineers within the Corps who work on rivers in the inland navigation system, I know of no set of criteria that a waterway must meet to be considered a "navigable waterway conducive to commercial navigation". As discussed in this report, there are inland waterways that do not operate 12 months of the year and operate, and, at least at times, with depths less than 9 feet. Also discussed in this report is that depths and widths on most or all waterways on the inland system were specified in the authorizing legislation and not based on a set of criteria. For example, the Missouri River operates for only 8-months of the year and during some years operates at an 8-foot depth. During the non-navigation season commercial sand and gravel miners operate on the river with 6 foot depths. I believe Mr. Ciarametaro's statement concerning criteria is his personal opinion.

b. *Ciarametaro* Opinion #2: Determination whether the Rio Grande "Interventions to enable future commercial navigation of the Rio Grande River are infeasible due to exorbitant costs, extensive time requirements,……". As discussed in this report there are a myriad of methods to improve the Rio Grande for navigation that range from discrete, localized improvements to a systemwide set of RTS or locks and dams. Any of these methods are well below, or comparable to, the cost compared of improvements undertaken on other rivers like the Missouri River or the upper Mississippi River. The improvements undertaken on the Missouri River, with 6 large upstream main-stem dams to supply water to the downstream navigation channel, and a 734-mile navigation channel obtained by 7,000 RTS many of which are miles in length, all constructed over 53 years (between 1927 and 1980), is very likely one of the largest engineering projects ever undertaken and was considered unfeasible and uneconomical at one time. As a result, the Missouri River is now a viable navigation project that continues to receive congressional funding. Since Mr. Ciarametaro has no training in economics, has not produced even a cursory economic review, and has never been involved in the politics of a navigable waterway, his opinions on the feasibility of improvements to the Rio Grande are not based on facts.

c. *Ciarametaro* Opinion #3.[5] On page 5, bullet #3, Mr. Ciarametaro offers his opinion that "The Rio Grande River poses significant challenges to transporting commercial cargo….unsuitability stems from substantial obstacles, including the need for extensive dredging and the implementation of a complex system of locks to obtain the necessary depths…..". This opinion is similar to Opinion #1 and #2 above. My response to Opinion #3 is the same as my response to Opinion #1 and #2.

Report of Carlos Rubinstein and Herman Settemeyer: Mr. Rubinstein and Herman Settemeyer provide the opinion (page 5) that "dredging of the Rio Grande from Falcon Reservoir to Amistad Reservoir and

[5] The numbering of Mr. Ciarametaro's opinions in his summary do not match the numbering in the body of the report.

"releasing water from Amistad Reservoir for navigation purposes" are "two scenarios that could conceivably be used to make the Rio Grande a navigable commercial waterway…..". Mr Rubinstein is not an engineer. Mr. Rubinstein and Mr. Settemeyer have extensive experience in water issues within the state of Texas but have no experience designing, constructing, or maintaining locks and dams or designing, constructing, or maintaining river training structures or any other navigation channel improvement method and have no experience conducting feasibility studies pertaining to river navigation improvement projects or preparing National Environmental Policy Act (NEPA) documents related to river navigation improvement projects. They have no experience in the preparation of Operation and Maintenance Manuals for any navigation improvement project. As discussed in this report there are a myriad of methods available to improve a river for navigation that range from discrete, localized improvements to a systemwide set of RTS that are well below the magnitude of scale and cost compared to improvements undertaken on other rivers. I do agree that releasing water from Amistad Reservoir for navigation is needed but the water released can be used for other purposes such as recreation and not just for navigation. Their lack of consideration for the full range of navigation improvement methods is a serious limitation in their report.

Report of Christine Magers and Cassandra Hart; Ms. Magers and Ms. Hart list their navigation improvement assumptions in Section 5 (pages 10-11) of their report. The following are their assumptions relevant to this report:

Assumption 1 – Depth Control via Water Releases: This assumption pertains to "raising and maintaining water levels" by increasing releases from Amistad Reservoir to obtain "depths of 9 to 12 feet" and "width of 100 to 125". They further state "This depth and width of dredging was assumed based on expert reports". They do not state what expert reports they are referring to and it is unclear why dredging is considered in this assumption. It is also unclear why they considered widths of 100 feet to 125 feet as a review of all expert reports does not indicate these widths were even considered. They further state that a detailed "hydraulic analysis" is needed (a hydrologic analysis is needed not a hydraulic analysis) to prove the availability of water and to complete a feasibility analysis.

Assumption 2 – Dredging: This assumption assumes the "dimensions would be obtained by dredging in low areas" (It is unclear what is meant by low areas) and is "based on USA expert reports". They further state calculations "about the locations and amount of dredge (sic) required to increase navigation were not provided" and "These calculations, along with where the dredge would be placed…..would be required to conduct a feasibility analysis". A review of Mr. MacAllister's report shows he proposes "Clearing/dredging of shoals", "Dredging of naturally shallow stretches of the river", and "dredging around boat ramps". It is unclear why Mr. Taylor's assumption of dredging 95,900,000 cubic yards of material (Taylor, Table 1, page 7) was not examined. Although Mr. MacAllister does not estimate a dredge quantity, his description of proposed dredging is almost certainly orders of magnitude less than the volume proposed by Mr. Taylor. Not analyzing Mr. Taylor's dredging volume and not estimating a dredging volume for Mr. MacAllister's proposed dredging, is a serious limitation in their report.

Assumption 3 -Locks and Dam System: This assumption pertains to creation of "a system of locks and dams proposed by OAG expert Ancil Taylor". They state that Mr. Taylor's proposed a depth of 9 feet, a channel bottom width of 150 feet, and 31 locks and dams. However, Mr. Taylor's assumed "a channel width of only 250 feet", "roughly 45 sets of locks and dams", and a "9-foot depth". These errors appear to be the result of a lack of attention to detail and are a serious limitation in their report.

In summary, there are numerous errors, omissions, and a disregard for the examination of the most extensive river improvement scenarios in Magers and Hart's report. They pick and choose which scenarios to examine. For example, for dredging they examine Mr. MacAllister's proposal but examine Mr. Taylor's lock and dam proposal. For these reasons, I question the veracity and applicability of the rest of their report.

7. Navigation Season Length, Flow Support, and Channel Dimensions

Ancil Taylor and Dr. Shields did not evaluate channel dimensions other than 9'x250' or a navigation season length of less than 365 days of the year. The lack of analysis of a more complete range of options was almost predetermined to result in evaluated options that present as impractical (too costly) or physically impossible (require more water than the system can provide). This is a serious limitation in their reports.

a. Navigation Season Length: A navigation season length of less than 365 days a year should be considered as a shorter navigation season will better suit the hydrology of the Rio Grande by saving water during the non-navigation season for release during the navigation season. The shorter the navigation season the more water can be stored during the non-navigation season allowing for higher releases during the navigation season, and hence, greater depths in the navigation channel. A navigation channel need not be functional 365 days a year to be considered viable. The Missouri River navigation season is 8 months, sometimes less, in length due to insufficient water in the system to support a 12-month season and due to adverse ice conditions during the winter. Releases from upstream dams are greatly reduced during the non-navigation season and increased during the navigation season to provide for increased channel dimensions. However, even during the low water non-navigation season, with depths of around 6 feet, commercial sand dredgers still operate on the river when the river is ice free. Likewise, the Mississippi River navigation channel above St. Louis, which is maintained by a system of locks and dams, is essentially closed during the winter due to adverse ice conditions.

b. Flow Support: As Adrian Cortez discusses (Cortez, p. 28), flows in the Rio Grande between Del Rio and Laredo are mostly determined by releases from Amistad Dam with minor contributions from tributaries below Amistad. Although Amistad releases are governed by a complex system of agreements and priorities, the releases could be changed to improve navigation. For instance, the storage and release schedule for Amistad could be changed to store water during the non-navigation season to allow releases to be increased during the navigation season. The details of how much water to store and how much to release versus the length of the navigation season would require a detailed study that is outside the scope of this report.

c. Channel Depth: Dr. Shields in his expert report states (Shields p. 6) "Modern commercial shallow draft waterways are designed to have a minimum water depth of 9 ft (USACE 1980, p. 3-2)". His reference for this statement is Engineering Manual (EM) 1110-2-1611. However, a review of the pages he references or the entire EM 1110-2-1611 does not support this statement. In fact, the EM says nothing about depths in existing navigation channels or that 9 feet should be a minimum depth. Ancil Taylor states (Taylor, p. 9) "I find that commercial navigation will require a channel 9 ft deep". But Mr. Taylor does not

provide even a cursory review of how he arrived at this finding. Based on the above, it appears that Dr. Shields and Ancil Taylor simply picked 9-feet as the needed depth without any analysis. The depths in existing navigation channels is usually determined by the language in the authorizing legislation. For instance, the depth in the Missouri River navigation channel was authorized to be 6 feet deep in legislation passed in 1927 while a subsequent 1945 authorization increased the depth to 9-feet. Even with the 9-foot depth in the authorizing legislation during dry periods the navigation channel is maintained to a depth of only 8-feet. Most or all navigation projects on the inland river system are authorized for 9-feet of depth to provide for a continuous depth throughout the interconnected system. However, since there is no congressional authority for a navigation channel on the Rio Grande, and since the Rio Grande does not connect to the inland river system, a channel depth of less than 9-feet should be considered and evaluated. While a channel depth less than 9-feet deep on the Rio Grande would require less flow and be more in line with the water available in the system, Dr. Shields (Shields p. 13) only examines the water requirement for 8, 9, 10, 11, 12 foot deep channels, all 250 feet wide, and provides no evaluation of depths less than 8 feet or depths in combination with widths of less than 250 feet. This is a serious defect in Dr. Shields analysis as it is unknown at this time what vessels or goods would transit the Rio Grande if it were improved. It is quite possible that vessels drafting just 3 feet may be viable.

d. Channel Width: Dr. Shields only examines flow requirements for a channel width of 250 feet[6] (Shields, p. 12) while Taylor only examines locks and dams for a 250 feet wide channel (Taylor, p. 9). This is a serious defect in their analysis. In the case of the Missouri River and many other rivers in the inland system, the authorizing legislation provides for a 300-foot wide channel. For the Missouri River, the 300-foot wide channel in the authorizing legislation simply reflected the width determined in previously conducted studies. EM 1110-2-1611 examines channel width in detail and provides guidance for calculation of an appropriate width. No studies have been conducted on the optimum width of a channel on the Rio Grande and therefore at this time a range of widths should be examined for completeness. A study of this type is outside the scope of this report. It is worth noting that EM 1110-2-1611 (page 4-3) discusses a range of possible channel widths down to 130 feet and states that "channel widths of less than 130 feet are not recommended for commercial traffic". Lacking detailed channel width studies for the Rio Grande that are outside the scope of this report, a channel widths down to 130 feet should be considered.

8. Methods to Improve Navigation on the Rio Grande

For this report the reach of the Rio Grande considered for navigation improvements extends from the weir at Del Rio to the weir at Laredo. These weirs would remain in place. While the text of this report uses examples from USACE projects, other federal, state, and private entities may have, or may desire to,

construct navigation improvement projects on other rivers within the nation. Any such projects may have depths, widths, or seasons that vary from USACE projects, but the methods to construct them will fall within the methods discussed in this report.

Ancil Taylor and Dr. Shields only evaluate two methods to improve navigation on the Rio Grande, namely, a complete system of locks and dams and an open river system without RTS that is obtained by flows alone. They do not consider any options beyond their grandiose schemes that are either very expensive to construct or severely tax the water supply in the Rio Grande system. However, there are a suite of options for improvement to navigation that they did not consider that range from simple, inexpensive, and only needed at discrete locations to systemwide improvements that are more costly and extensive but an order of magnitude simpler and cheaper than Taylor's $58 billion system of locks and dams or Dr. Shield's water hungry 9'x250' channel available 365 days of the year.

The suite of options, not considered by Taylor and Shields, are discussed in the following sections.

A. Incremental Methods to Improve Navigation on the Rio Grande

Incremental methods to improve navigation are defined here as actions that can be taken that are simple to accomplish and do not require they be accomplished in a systemwide manner.

Rather, incremental actions can be accomplished at discrete locations to improve navigation at areas that are currently the most difficult to navigate. Since navigation between any two points in a river, in this case Del Rio and Laredo, is restricted by the location with the most adverse channel condition (restriction point), incremental methods can be used to improve channel conditions at restriction points that improve navigation along the entire reach. For example, say a very shallow and narrow rock shoal exists in the river half-way between Del Rio and Laredo that requires a vessel to draft[7] 1-foot but the rest of the river could support a vessel with a 3-foot draft. A vessel transiting between Del Rio and Laredo is restricted to 1-foot of draft due to this one rock shoal. Improving the restriction point to provide for a 3-foot draft in effect improves navigation along the entire reach between Del Rio and Laredo as now a vessel can draft 3-feet for the entire distance.

i. Reduce or eliminate flows through Maverick Canal and Powerplant when flows through the canal cause reduced flows in the adjacent Rio Grande that result in a navigation restriction point. Adrian Cortez states that the Maverick Canal can divert up to 1,500 cubic feet per second[8] (cfs) (Cortez, page 30) which reduces flows in the adjacent river by that same amount. This flow diversion has more of an adverse impact to navigation when flows in the Rio Grande are below 4,000 cfs than when flows are higher. As flows in the Rio Grande increase the 1,500 cfs flow in the Maverick Canal becomes less of the overall flow and therefore has less impact to the navigation channel. A detailed study, outside the scope of this report, would need to be conducted to determine at what flows diversions into the canal should be curtailed.

ii. Mechanical removal of portions of the rock shelfs observed in the river as discussed on page 10. Observations during the site visit indicated that generally, outside the Maverick Canal, the rock

[7] Draft is how far down a vessel sits in the water while depth is the distance between the water surface and the bed of the river. Since vessels could be damaged by scraping the bottom, depth should be at least 5 inches greater than draft.

[8] Cubic feet per second is the amount of water, measured as a cube 1 foot on each side, that passes a cross section of the river in one second.

shelfs are currently the most limiting factor to navigation as the shelfs require vessels to reduce draft and carefully maneuver across the shelf. As discussed above the rocks appear to be sitting on sand and gravel and can likely be removed by a trackhoe (Figure 8). The rocks can be salvaged and used to construct bank stabilization structures such as revetments.

Figure 8: An example of a trackhoe operating in a river environment. This method could be used to remove rock from existing rock shelfs to improve navigation.

iii. Construction of River Training Structures (RTS). RTS are structures constructed in the river using rock obtained from quarries that direct and confine the flow of the river into the portion of the river desired to be navigable (RTS are discussed in detail below). A few of these rock structures could be constructed at locations with critical navigation restriction points to improve navigation at those points, with the effect of improving navigation throughout the entire reach of the river.

iv. Realignment of tight bends. Natural rivers meander around their floodplains over time. The rate of meander is different for every river and is dependent on the erodibility of the material in the floodplain. Rivers often have sharp bends that can make navigation difficult due to the requirement to quickly maneuver a vessel through the bend. In addition, tight bends often have higher velocities on the outside of the bend and decreased width overall. Channel realignments, which decrease the curvature of a bend can be undertaken at these locations. The realignment is accomplished by excavation of the new desired alignment and construction of stone structures to block off the old alignment (Figure 9).

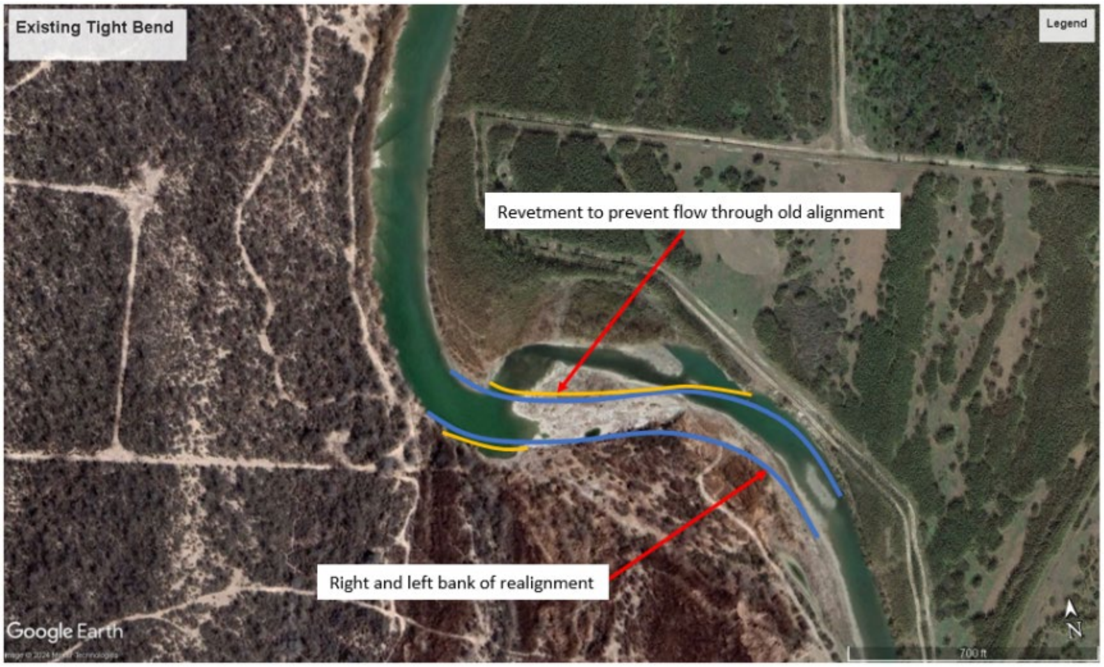


Figure 9: An example of a realignment of a tight bend. Located about 31 miles downstream of Del Rio.

v. Removal of weirs: A review of Google Earth shows that there are two weirs that cross the channel between Del Rio and Laredo. One appears to be associated with the Maverick canal and the nature and reason for the other weir is unknown. These structures may need to be modified or removed to facilitate navigation. The Maverick structure could be replaced with a pumping plant in order to pump water into the canal or RTS could be constructed to force water to split between the Rio Grande and the canal. Since the nature of the other weir is unknown, it is not possible to offer an alternative to this structure.

B. Systemwide Methods to Improve Navigation on the Rio Grande

There are two methods to improve a river for navigation systemwide; locks and dams and an open river modified by River Training Structures (RTS) to create a navigation channel. Both methods can be augmented by dredging of sand and gravel deposits in the navigable channel. However, for this report, dredging alone is not considered a method to improve navigation due to the high cost associated with dredging and the need to continue maintenance dredging indefinitely and the availability of simpler and more cost effective options discussed in this report.

It should be noted that Dr. Shields and Mr. Taylor have very limited or no experience with the design, construction, or monitoring of locks and dams or RTS. Due to this lack of experience, Dr. Shields and Mr. Taylor are not qualified to provide opinions on the design, construction, or monitoring of either locks and dams or RTS. In fact they only mention RTS in passing and perform no analysis to determine if RTS are feasible, economical, or practical.

i. Locks and Dams. This method involves construction of low elevation dams across a river with a navigation lock built into the dam (Figure 10). The dam creates a pool of water upstream with depths adequate to navigate. The lock is a chamber with gates on the

upstream and downstream side. Boats enter the lock, the gates are closed, and water is either drained or added to the lock to lower or lift the boat to the water elevation upstream or downstream of the dam depending on which direction the boat is transiting, the boat then exits the lock. Generally, locks are used where the water supply is limited which prevents construction of an open river system without RTS or the slope (defined as the drop in elevation of the water surface in the downstream direction) of the river is extremely steep which could cause high velocities that makes navigation difficult, or the water surface is relatively flat. Although navigation on the Rio Grande could be improved by the construction of locks and dams, this method will have high construction costs, long lead times to design and build, and the likelihood of submergence of adjacent valuable floodplain land.

Figure 10: John C Stennis Lock and Dam on the Tombigbee River.

ii. River Training Structures (RTS). RTS are structures (Figure 11) constructed directly in a river to stabilize a river in one location and focus the flow of water into a desired alignment where the flow scours[9] the sands and gravels in the bed of the river thereby creating a deeper navigable channel. The scoured sand and gravel are transported downstream out of the reach or deposit in areas outside the navigable channel. RTS are almost always constructed using large stone, wood piling, or a combination of stone and piling. Over the last roughly 80 years, wood piling has become expensive and scarce while the ability to quarry and move large amounts of stone has become very economical. As a result, almost all RTS constructed in the last 80 years or so are constructed of quarried stone. Additionally, RTS constructed with quarried stone are more durable and require less maintenance than RTS constructed with wood piling. RTS are used on rivers with flow rates and velocities sufficient to scour sands and gravels in the bed and where the bed of the river is composed of sand and gravel instead of bedrock.

[9] Scour is the action of flowing water lifting sand and gravel from the bed and banks of the river and transporting that material downstream either suspended in the water or skipping across the riverbed.

Figure 11: River Training Structure constructed of quarried stone (left) and wood piling (right). Both photos taken on Missouri River below Hermann Missouri. Photo on left was taken 2023 and photo on right was taken 1938.

9. River Training Structures

RTS block flow in selected areas of the river and concentrate flow into the navigable portion of a river. The concentrated flow, especially during higher stages, scours the sands and gravels in the navigable portion of the river thereby increasing depths. The height of RTS do not need to be such that flow is blocked at all flow levels experienced in a river. Generally, the height of RTS need only be 3 to 5 feet above a flow that is exceeded 75% of the time[10] (defined henceforth as 'normal flow level').

a. Dikes: A dike is a RTS that is orientated perpendicular or nearly perpendicular to the direction of flow of water in the river. A dike extends from one bank of the river for a specified distance out into the river with a top elevation that is usually about 2 feet above normal flow level. Dikes are usually constructed in a series on one side of a river at any one location. However, it may be desired to construct dikes on both sides of the river at a particular location if the alignment of the river is such that a smooth navigable alignment is not achieved by dikes on one side only. Since dikes are constructed next to the bank of the river and block flow in these areas, flow is concentrated toward the middle of the river where navigation takes place.

[10] Flows are commonly referenced to as 'exceedance' values in Hydrologic Engineering. The average flow for each day for a selected period of time (usually at least a decade or two) is listed in a table. The table is then sorted highest to lowest. The flow in the middle of the sorted table is exceeded 50% of the time, the flow ¾ of the way down the table is exceeded 75% of the time, etc.

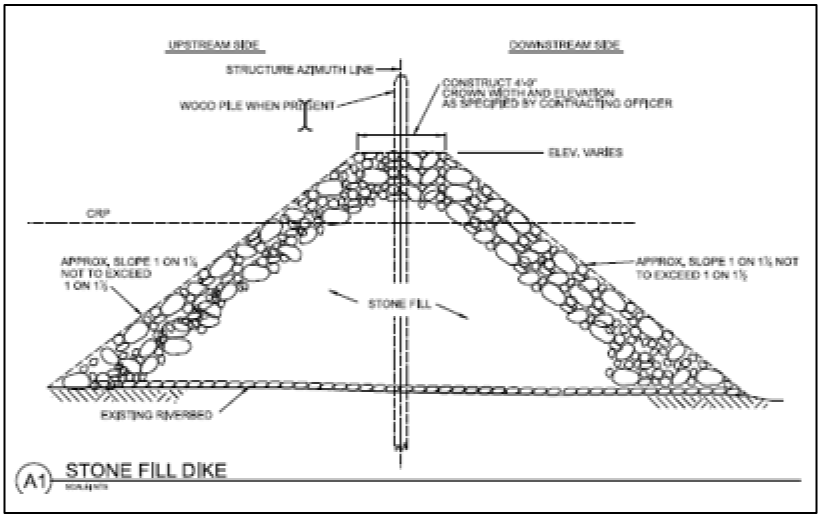


Figure 12: Cross section of a stone fill dike.

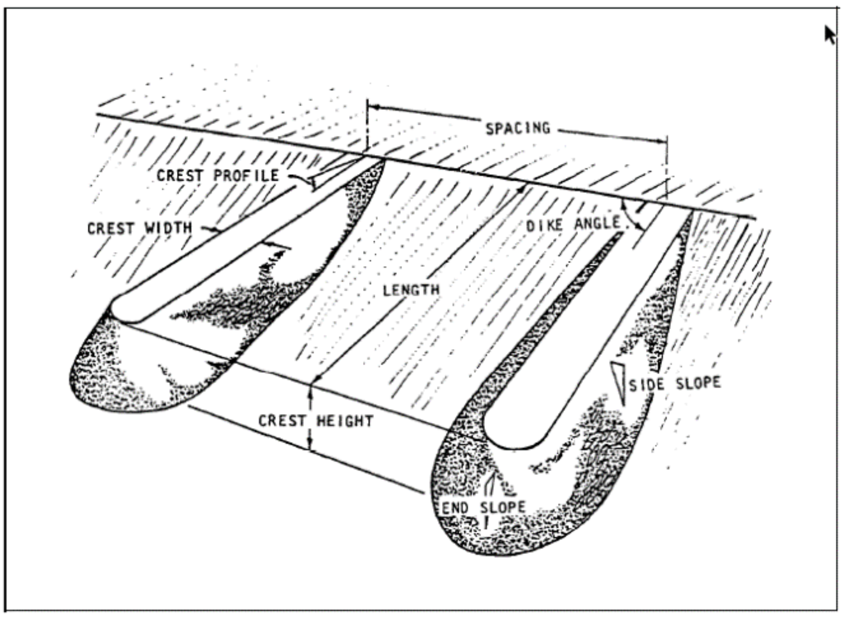


Figure 13: Example of the layout of two dikes.

b. Revetments: A revetment is orientated parallel with flow and is used to establish the outside edge of the navigable portion of the river and hence prevent flow from leaving the navigable portion of the river. Revetments are almost always constructed on the side of the river opposite of dikes. Revetments called Toe Trench Revetments, can be constructed on an existing bank if the existing bank is located in the desired location. Conversely Stone Fill Revetments are constructed riverward of the bank if the existing bank is not in the desired location and would provide for poor channel alignment (Figure 15). Revetments are usually constructed to an elevation of 3 feet above normal flow. In all cases, revetments guide the flow along a desired navigable alignment and concentrate flow within that alignment.

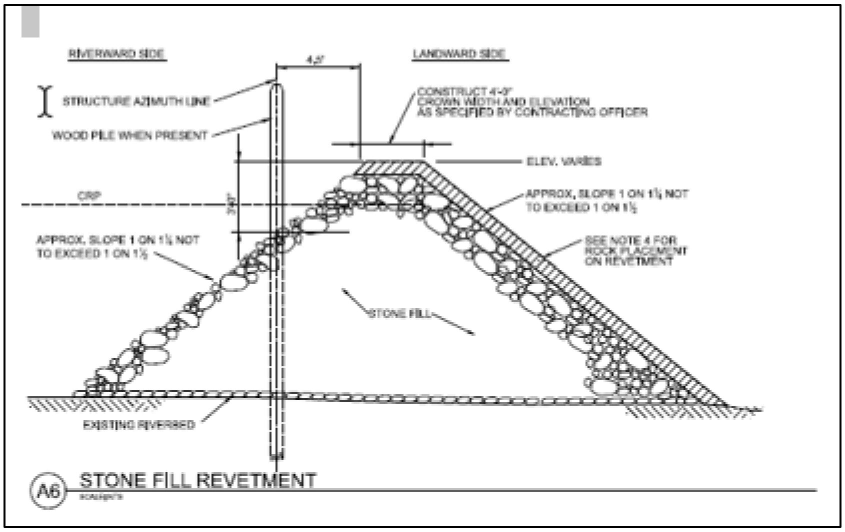


Figure 14: Cross section of a stone fill revetment.

Figure 15: Stone fill revetment constructed riverward of an existing bank.

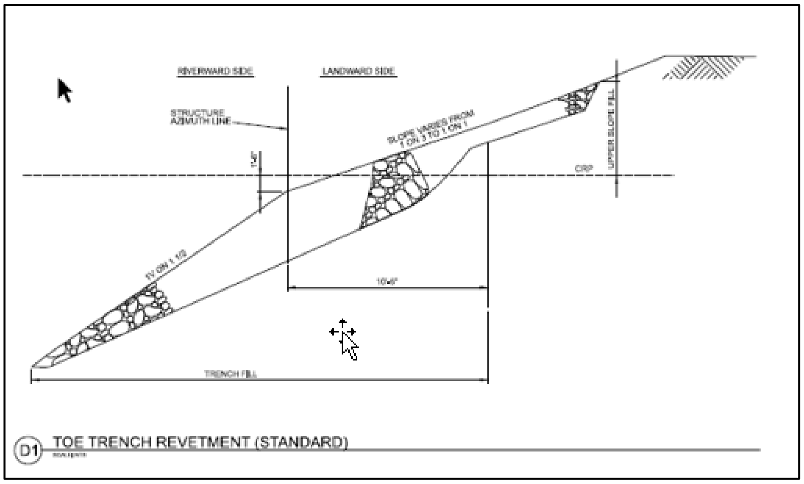


Figure 16: Cross section of a toe trench revetment.

Figure 17: Recently repaired toe trench revetment.

c. L- Head Dike: A L-Head dike is a type of dike that has a revetment constructed at the riverward end of the dike. The revetment starts at the dike and extends downstream parallel with flow. L-Head dikes are placed on the outside bend of a river and are used to establish the edge of the navigable portion of the river. The dike blocks flow outside the navigable portion of the river while the revetment prevents flow turbulence that develops when a dike extends into a river near the navigable portion of the river. L-heads are not used on inside bends as flow and turbulence are not as strong on inside bends as on outside bends. L-Head Dikes are generally constructed to elevations of 4 feet above normal flows.

Figure 18: Aerial view of L-head dikes on the Missouri River

d. Kicker Structures: A kicker structure is a type of L-Head dike that is used to direct flow from one side of the river to the other side of the river. Rivers do not flow in a straight line, but 'meander' in a sinuous pattern (see Figure 2). In a bend, flow is concentrated near the outside bank where the river is deeper. The bends continuously alternate as one moves upstream or downstream; left bank bend[11] followed by a right bank bend, followed by a left bank bend, etc. Between bends are channel crossings where flow is not as uniform as in bends and navigable depths are less predictable. Kicker Structures are built in channel crossings and are generally built 5 feet above normal flow levels and slightly more riverward than L-Heads and thus provide more concentration of flow in the channel crossings and hence more reliable depths.

[11] Left and right bank are always defined when looking downstream.

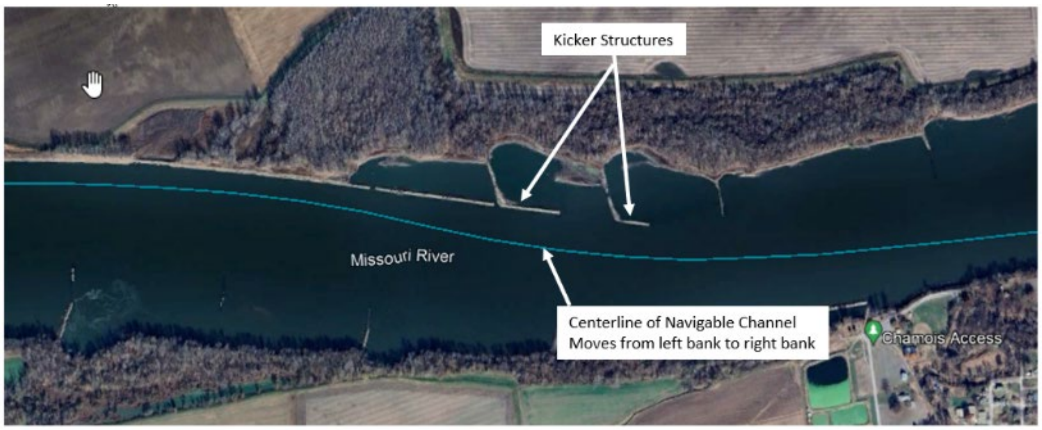


Figure 19: Aerial view of two Kicker structures on the Missouri River located at a channel crossing where the channel moves from the left descending bank to the right descending bank.

e. Side Channel Chute Closure: A side channel chute closure prevents flow from exiting the navigable portion of the river and flowing downstream in a side channel chute that reconnects with the river a distance downstream. A side channel chute closure concentrates flow in the navigable portion of the river thereby increasing depths. Chute closures are normally built 2 feet above normal flow.

Figure 20: Aerial view of a side channel chute closure on the Missouri River.

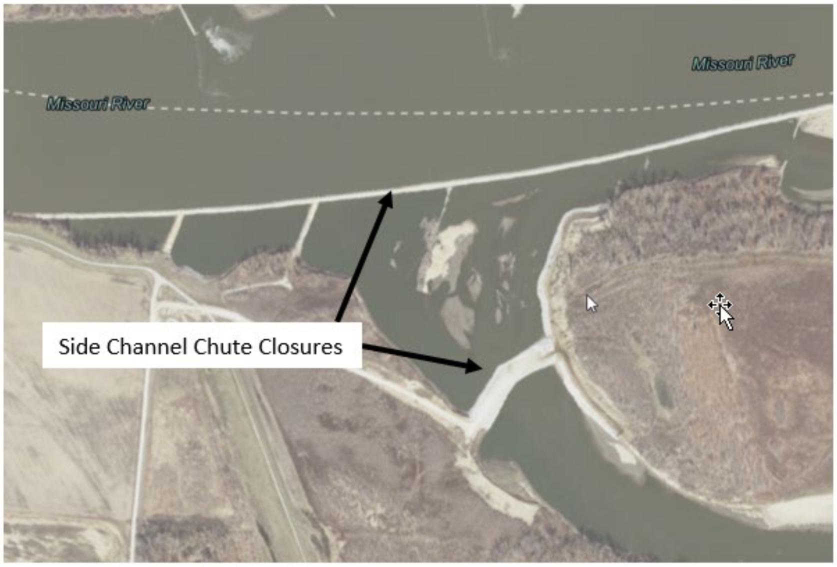


Figure 21: Aerial view of redundant side channel chute closures on the Missouri River.

The RTS discussed above can be constructed in a wide array of combinations and it is up to the designer to work with the natural layout of the river as much as possible rather than force the river into unnatural bends and alignments. RTS should be constructed in test reaches first, monitored over a period of 5 years or so, lessons learned documented, and additional RTS designed and constructed on the remaining parts of the river. An example of existing RTS layout on the Missouri River is shown in Figure 22.

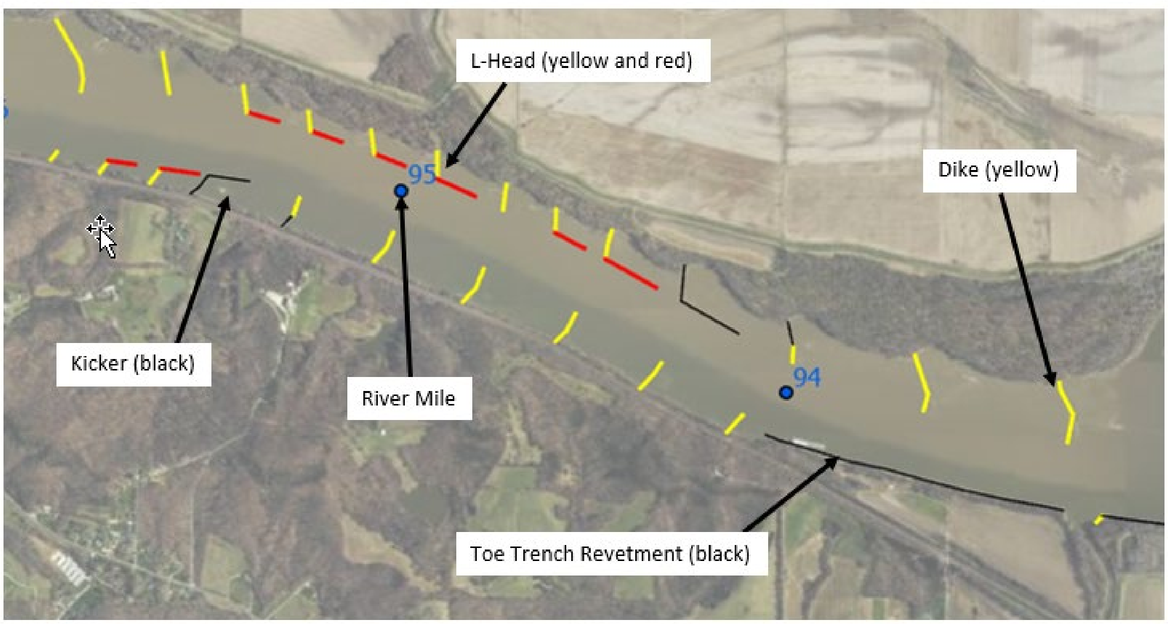


Figure 22: Aerial view of RTS layout on the Missouri River below Hermann Missouri.

10. Navigable Channel Alignment

As discussed and illustrated above (Figure 2)(Figure 19), rivers do not flow in straight lines but flow in a sinuous pattern. The sinuous pattern is not uniform and at locations the bend may be too sharp or too straight. A bend that is too sharp can be difficult to navigate and can lead to flow highly concentrated against the outside bank which creates a narrow channel while a bend that is too flat (straight) can cause sand and gravel to deposit within the navigable portion of the river thereby reducing depths. To improve navigation on a river, at locations it may be necessary to change the alignment of the river to create smooth and uniform bends (Figure 23).

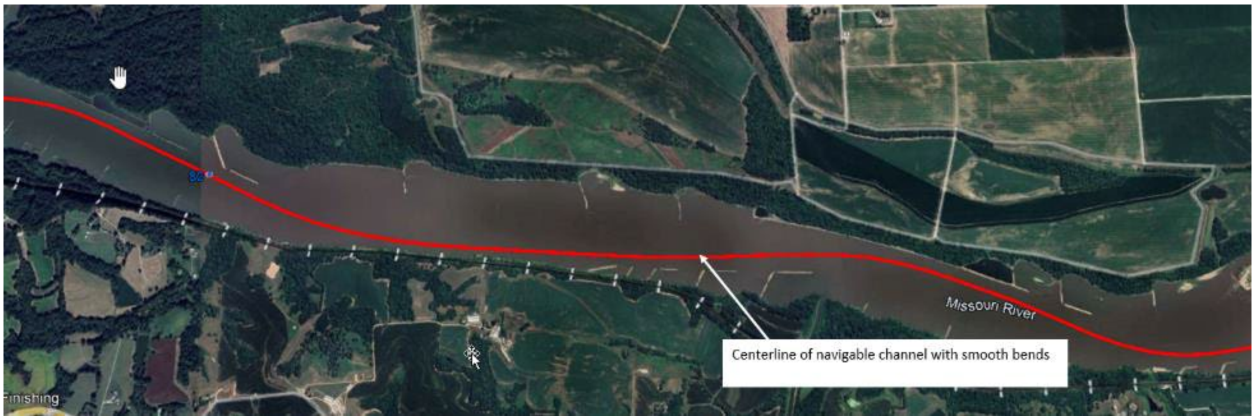


Figure 23: Aerial view of the Missouri River with smooth bends. Photo near Washington Missouri.

11. Construction of River Training Structures

Current practice in the Corps, and to my knowledge any entities that construct RTS, is to construct them with quarried stone (page 23). Quarried stone is durable, relatively inexpensive, and not permeable to flow like wood piling. Quarried stone is easily handled by common construction equipment such as dump trucks, trackhoes, and bulldozers. RTS can be constructed by either floating plant or land-based equipment.

It is noted that neither Dr. Shields nor Ancil Taylor have any experience in the construction of RTS by either floating plant or land-based equipment. This lack of experience precludes them from understanding how RTS can be constructed or even if they can be constructed.

a. As the name implies, floating plant is construction equipment that floats on water. Floating plant consists of barges that hold either construction equipment or quarried stone and towboats with engines that move the barges to the desired location. Floating plant is commonly used on larger rivers by a limited number of contractors since barges, spud barges. and towboats suitable to constructing RTS in a marine environment with strong currents and limited room to maneuver are very specialized equipment with a limited range of general construction applicability.

Figure 24: A towboat pushing a barge loaded with rock on the Missouri River. Towboat drafts about 4 feet and loaded barge drafts about 6 feet. However, some towboats and barges on the Missouri River draft only 3 feet and 4 feet respectively.

Figure 25: A spud barge with a trackhoe working to place rock on a RTS and an almost empty rock barge. Draft of spud barge is 3 feet.

b. Conversely, land-based equipment is construction equipment that sits directly on land or on the RTS being constructed. The equipment needed for land-based RTS construction is widely available and the pool of contractors is large since the equipment is widely available and building RTS with land-based equipment is similar to many common types of construction.

Figure 26: Land based equipment working on the Missouri River. Equipment in picture includes bulldozer, trackhoe, and dump trucks.

Figure 27: Land based equipment working on the Missouri River. Equipment in picture includes dump truck and small boat for personnel rescue if needed.

For the Rio Grande, RTS construction by land-based equipment would be the best construction method since the river is initially very shallow and floating plant equipment is generally hard to obtain.

12. Quarries and Stone

A review of Google Earth aerial photos and internet searches show that there are numerous quarries that exist within relatively close proximity to the Rio Grande. Quarries are usually able to produce stone to any required specification. Stone excavated from the quarries can be moved by truck to the location of each RTS.

Stone used in the construction of RTS must be durable and not subject to breakage during transport and handling and must be able to withstand submergence in water without changes to the character of the stone. RTS stone is larger than stone commonly used for other types of construction, however, the stone is not so large that specialized equipment is necessary. A typical stone gradation curve used on rivers with higher velocities such as the Rio Grande is illustrated in Figure 28 below. Figure 29 shows part of a gradation test to ensure stone complies with gradation curves and shows stone stockpiled in a quarry awaiting transport.

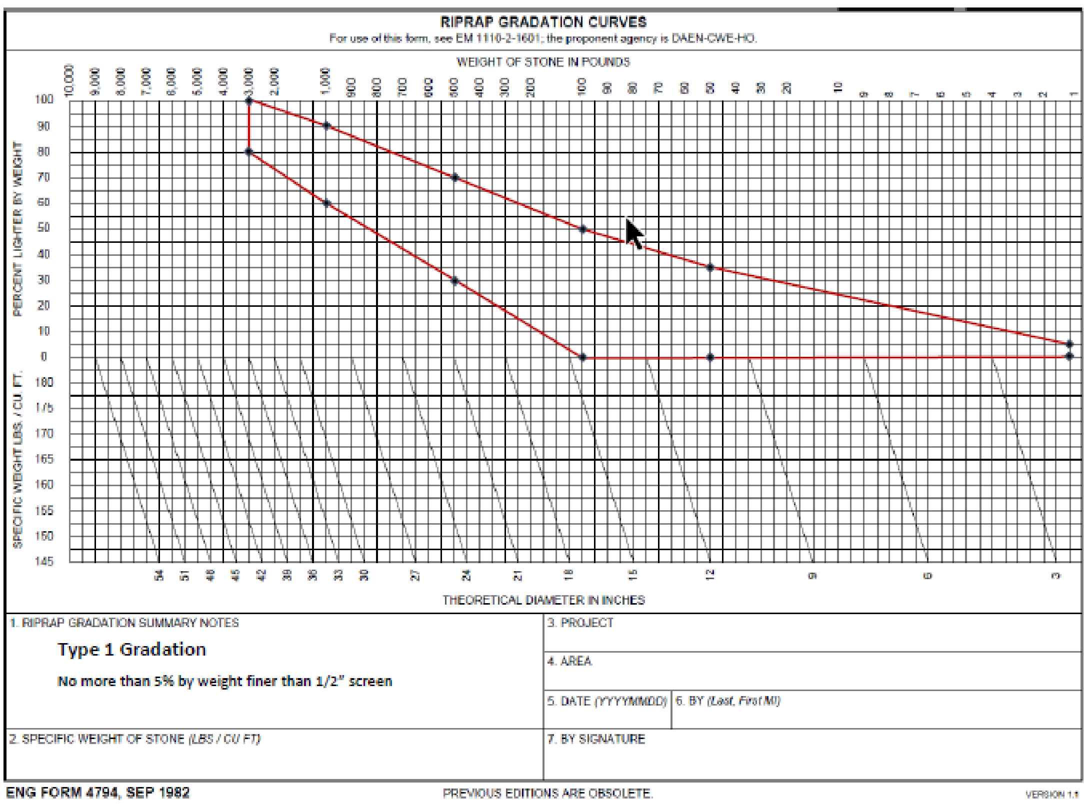


Figure 28: Gradation curves for stone used to construct RTS in streams with high velocities.

Figure 29: Stone being measured at a quarry to ensure compliance with gradation curves and stone stockpiled in quarry awaiting transport.

13. Schematic of Proposed RTS Overlaid on a portion of Rio Grande

The examples below illustrate a full build out of RTS on random sections of the Rio Grande. These examples should be viewed as the maximum number and length of structures needed. A more detailed investigation, along with test reaches using constructed RTS, would be needed to better determine the structure spacing required, length of each structure needed, and height above the streambed. Not all structures within each reach would be needed to achieve improvements to navigation. Rather, any fraction of structures will improve navigability by some amount.

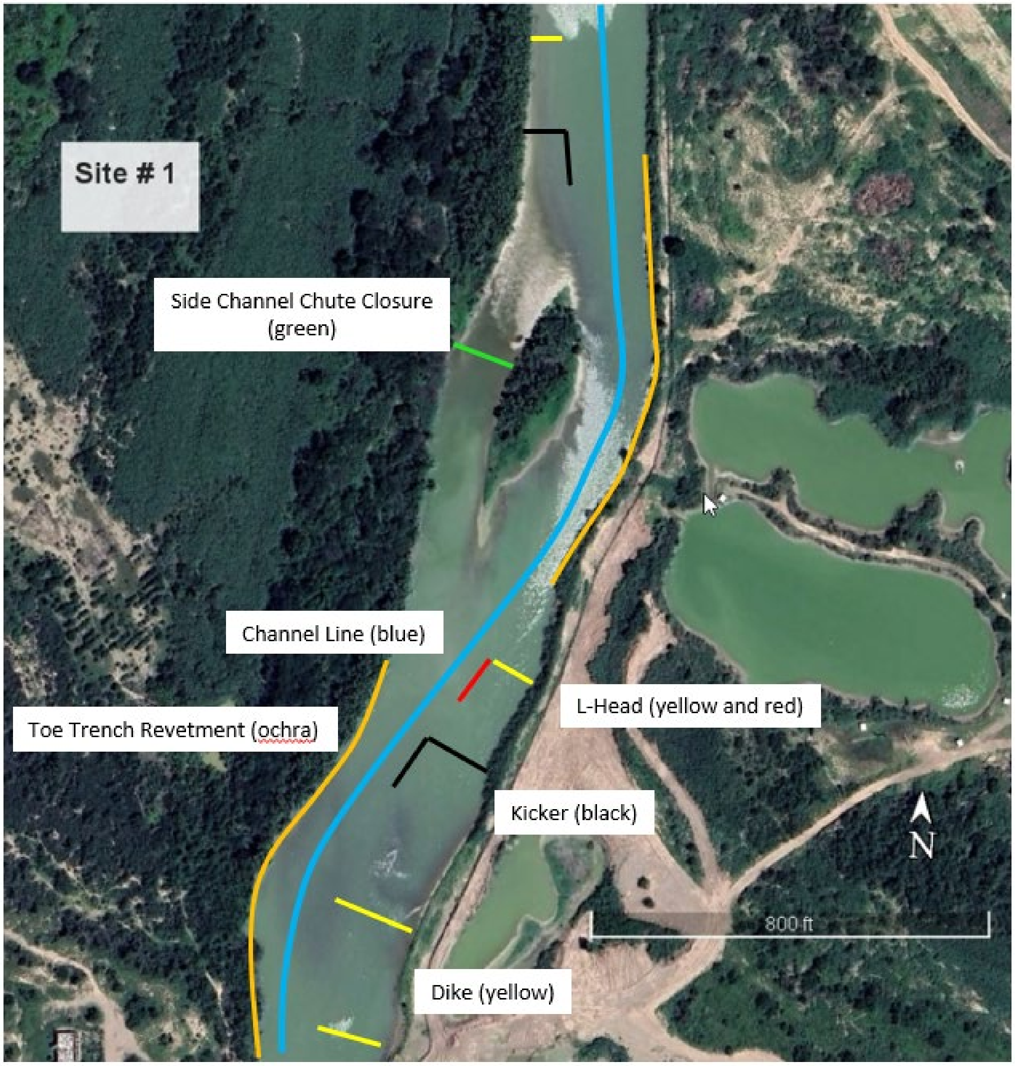


Figure 30: Hypothetical layout of RTS on a reach of the Rio Grande. Immediately upstream of Eagle Pass.

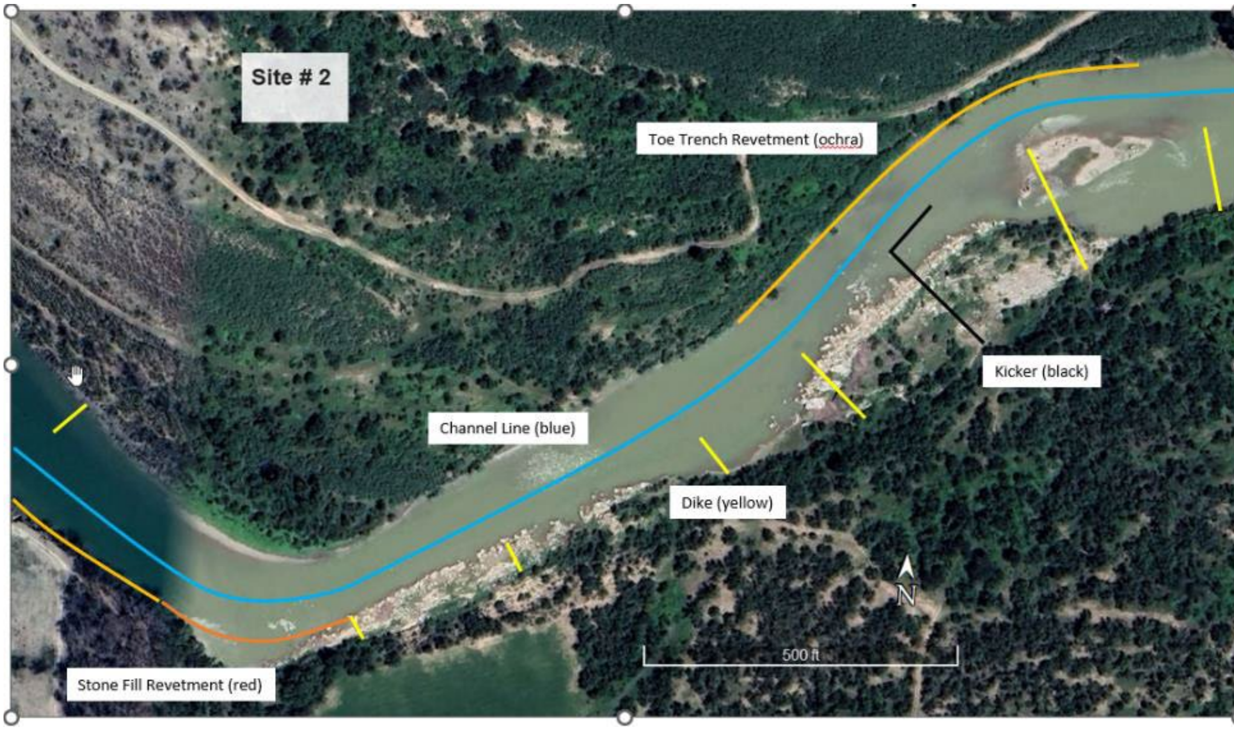


Figure 31: Hypothetical layout of RTS on a reach of the Rio Grande. Ten miles upstream of Eagle Pass.

14. Cost to Improve Navigation

The structures shown in the examples above are considered the full suite of structures needed to improve navigability on the Rio Grande between Del Rio and Laredo by means of RTS. In order to calculate a construction cost per mile, I assumed that the average height of each structure above the riverbed is 8 feet. The contract unit for the construction of RTS is tons placed. The highest unit price seen on the BSNP is $110/ton for hard to access floating plant work and $60/ton for hard to access land-based work. For this discussion, land-based equipment was assumed and a conservate unit price of $90/ton was used.

I also calculated the cost to remove portions of the 45 rock shoals (Taylor, page 10) in the subject reach. I used a removal width of 160 feet[12], an upstream/downstream distance of 130 feet, and a depth of cut of 10 feet[13].

As discussed earlier, some channel realignments will be needed in areas of sharp bends. A review of the river in Google Earth Pro showed about 45 areas will need realignment. For this cost I assumed each location will be 1,500 feet long, 250 feet wide[14], and 15 feet depth of cut[15].

[12] I assumed a minimum channel width of 130 feet as recommended in EM 1110-2-1611 and added 15 feet of clearance on both sides.
[13] Assumed rock in shoal to be 3 feet thick plus removal of 7 feet of sand and gravel under rock.
[14] Width greater than navigation channel width to allow for flow conveyance during high flows.
[15] Assumed all area landward of existing bank so cut is top of bank to bottom of channel.

Total cost calculated to be $2.2 Billion. Factoring in contingency, design, and contract supervision and administration, the cost estimate should be increased to around $2.7 Billion.

As discussed in this report, a systemwide full buildout of RTS is not needed to incrementally improve navigation on the Rio Grande. Any fraction of the suite of improvements detailed in this document can be constructed that will improve navigation. Smaller improvements, such as removal of some rock from say 5 rock shoals could cost less than $1 Million.

15. Effects of Proposed RTS on Rio Grande

As RTS are constructed and rock shelfs mechanically removed as needed, the river will scour the bed of the navigation channel during higher flow. The scoured sands and gravel will deposit in areas of the river that are outside the navigation channel such as between the dikes and landward of L-Heads and kickers. The timeline for development of a navigable channel will be dependent on precipitation in the basin and the resulting flows in the river. The higher the flows and the longer flows remain high, the sooner the river will respond to the presence of the RTS. Conversely, extended periods of drought and associated low flows will extend the period of time it takes the river to respond to the presence of the RTS.

The scour induced by the RTS means that the depth in the navigation channel is not 'on top' of the existing bed but actually at least partially below the existing bed. How much scour occurs and how much depth is obtained by the scour verses depth obtained by the height of increasing flows will need to be examined in the field once RTS are constructed in a few locations. This information could then be used to help determine the heights of RTS.

Once the river has adjusted to the RTS, it is expected that the slope of the river will smooth out and become uniform. The areas of high slope and turbulence caused by rocks as shown in Figure 5 will flatten out by a process known as head-cutting. Head-cutting happens when the bed of a river adjusts to the removal of a hard, fixed object such as a layer of rocks or say a low weir. Prior to removal, the slope of the riverbed and water surface drops rapidly as water flows over the hard fixed object. After removal of the hard, fixed object, erosion of the bed upstream and deposition downstream adjusts the bed and water surface slopes so that the slope is uniform upstream, at, and downstream of the location of the removed hard fixed object. This uniformity of slope and depth will greatly improve navigability.

16. Flow Requirements for a Navigation Channel

To understand the flow requirements for a navigable channel and compare the total flow to the water available in the system, I calculated the flow required for a channel 130 feet wide[16]. I used the same method as Dr. Shields to calculate flow (Shields page 11). I also used the channel slope[17] and Manning value used by Dr. Shields (Shields page 12)[18], I then calculated the annual water needs for the selected channel depths assuming an 8-month and a 6-month navigation season. Dr. Shields cites (Shields page 15) that average annual discharge at Laredo to be 2.08 million acre-feet. I then compared the annual

[16] For my calculations I added 15 feet on each side of the channel for clearance for a total of 160 feet width.

[17] Dr. Shields used a range of slopes but cited Taylor for the slope in the Eagle Pass area as 0.00043.

[18] I was unable to reproduce Dr. Shields values in his Table 2. My values were approximately 85% of his values using his same numbers.

water needs of the navigation channel for the selected depths to the 2.08 million acre-feet value (Table 1).

Table 1: Selected channel depths and corresponding water needs.

Channel Depth (feet)	Discharge (cfs) Needed	8 Month Season Water Need (acre-ft)	6 Month Season Water Need (acre-ft)	8 Month Season Water Need as Percent of Average Annual Flow at Laredo*	6 Month Season Water Need as Percent of Average Annual Flow at Laredo*
5	1,735	837,155	627,866	40%	30%
6	2,333	1,125,611	844,208	54%	41%
7	2,994	1,444,173	1,083,130	69%	52%
8	3,711	1,790,455	1,342,841	86%	65%
* From Shields, page 15					

As shown in the table above, the water needs for up to a 8-foot deep/8 month navigation season can be meet in most years with the water in the basin. During years of drought, a shorter season or less depth may be required. A more comprehensive study, outside the scope of this report, would be required to fully examine the water needs and the water supply. Part of that study would need to look at construction of a re-regulation dam[19] downstream of Amistad if Amistad continues to make power releases which vary through the day.

17. Documents Reviewed

1. Expert Report of Mr. Ancil Taylor
2. Expert Report of Dr. Doug Shields
3. Expert Report of Mr. Timothy MacAllister
4. Expert Report of Mr. Adrian Cortez
5. Expert Report of Mr. Thomas Ciarametaro
6. Expert Report of Carlos Rubinstein and Herman Settemeyer
7. Expert Report of Ms. Magers and Ms. Hart
8. Soundings: 100 years of the Missouri River Navigation Project, 1996. U.S Army Corps of Engineers, Kansas City District
9. Engineer Manual 1110-2-1611 – Layout and Design of Shallow Draft Waterways, U.S. Army Corps of Engineers.
10. Design Criteria of the Missouri River Bank Stabilization and Navigation Project, U.S Army Corps of Engineers, Kansas City and Omaha Districts, 1994
11. Navigability Study, Rio Grande, Tributaries, and Lakes, U.S. Army Corps of Engineers, 1975
12. Missouri River Bank Stabilization and Navigation Project – Structure Maintenance Guidelines, U.S. Army Corps of Engineers, Kansas City and Omaha Districts, 1988

[19] A re-regulation dam is a smaller dam and reservoir built downstream of a power generating dam. The re-regulation dam smooths out the cyclical flows that power generation usually produces.

18. Previous Expert Testimony

I have not given deposition or trial testimony in the last 5 years.

19. Statement of Compensation

I am an employee of the United States Army Corps of Engineers and have not been provided compensation beyond my normal salary and benefits.

20. Conclusions

The Rio Grande can be improved for navigation by any of a suite of actions that range from low cost, simple, localized, and incremental, such as removal of portions of selected rock shoals, to more systemwide improvements such as the construction of a full suite of River Training Structures or locks and dams.

Mr. Taylor and Dr. Shields failed to look at options to improve navigation that were anything but grandiose and infeasible. Their results were forgone conclusions.

21. Signature

I, Michael Chapman, based on my experience and consideration of the documents, materials, facts, and data cited in Section 17 and/or cited elsewhere in this report reached the conclusions and opinions contained herein.

Dated July 11, 2024

Michael Chapman

Michael D. Chapman
Senior Technical Lead
U.S. Army Corps of Engineers, Kansas City District

Appendix A: Sample of water needs calculation.

Seconds in a year			
Minute	60	Flow Rate (cfs)	3,711
Minute/hr	60		
hrs/day	24	Flow/yr (cubic feet)	1.17042E+11
days/year	365		
		Flow/yr (acre-ft)	2,685,683
seconds/yr	31,536,000		
		Flow/8 months (acre-ft)	1,790,455
		Flow/6 months (acre-ft)	1,342,841
		Average Annual Discharge at Laredo (acre-ft)**	2,080,000.00

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [\text{U.S.}]$$

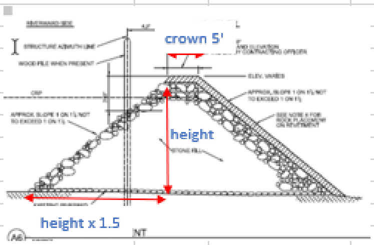
		Percentage (8 month season)	86%
		Percentage (6 month season)	65%
Q (cfs)=	3,711		
		hydraulic radius =	7.272727273
n=	0.04	width* =	160
area=	1280	depth =	8
Hydr Rad=	7.273		
slope=	0.00043	area =	1280

* 30' added for slope of outside bank and clearance from structures

** from Shields, page 15

Appendix B: Cost Calculations for a System of River Training Structures.

Length of structures	Site #1	Site #2
Dike	700	1000
Stone fill revetment		300
L head	900	500
Toe trench revetme	2200	1300
Chute Closure	150	
feet	3950	3100



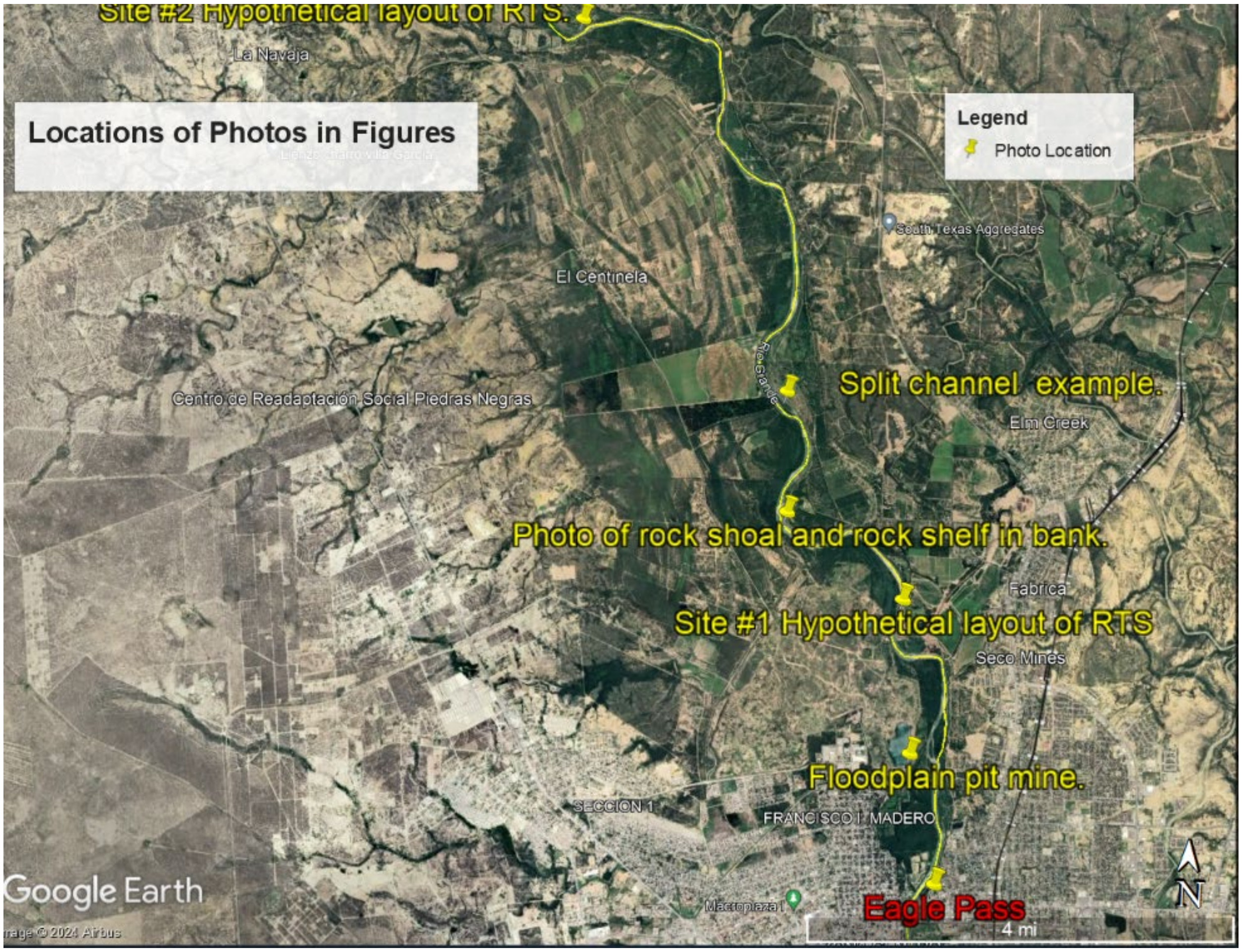
volume (square fee	5x8	40
	12x8	96
		136
volume (cubic yards)		5.04
tons (1.5 conversion factor)		7.56

Channel Realignments	
Number of locations	35
Length (feet)	1500
Width (feet)	250
Depth of cut (feet)	15
cy/site	208,333
cubic yards all sites	7,291,667
cost/cy	$ 60.00
total costs	$ 437,500,000.00

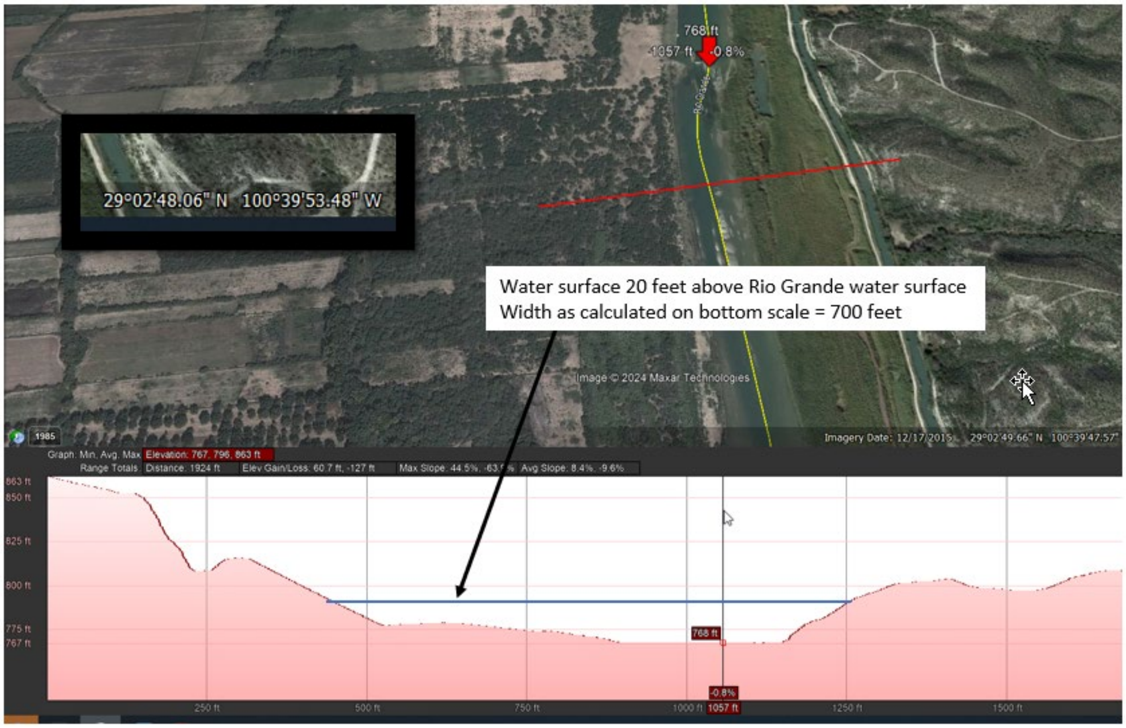
			Site #1	Site #2
Length of RTS per site			3950	3100
Average height above stream bed = 3 feet				
Average depth below water surface = 4 feet				
Tons/ft			7.56	7.56
Price/ton	$ 90.00		$ 90.00	$ 90.00
			$ 2,686,000.00	$ 2,108,000.00
Length of site #1&2 = 2400 feet				
		average cost	$ 2,397,000	
		cost/mile	$ 5,273,400	
		Total RTS	$ 1,766,589,000	
Length of river = 335 miles				

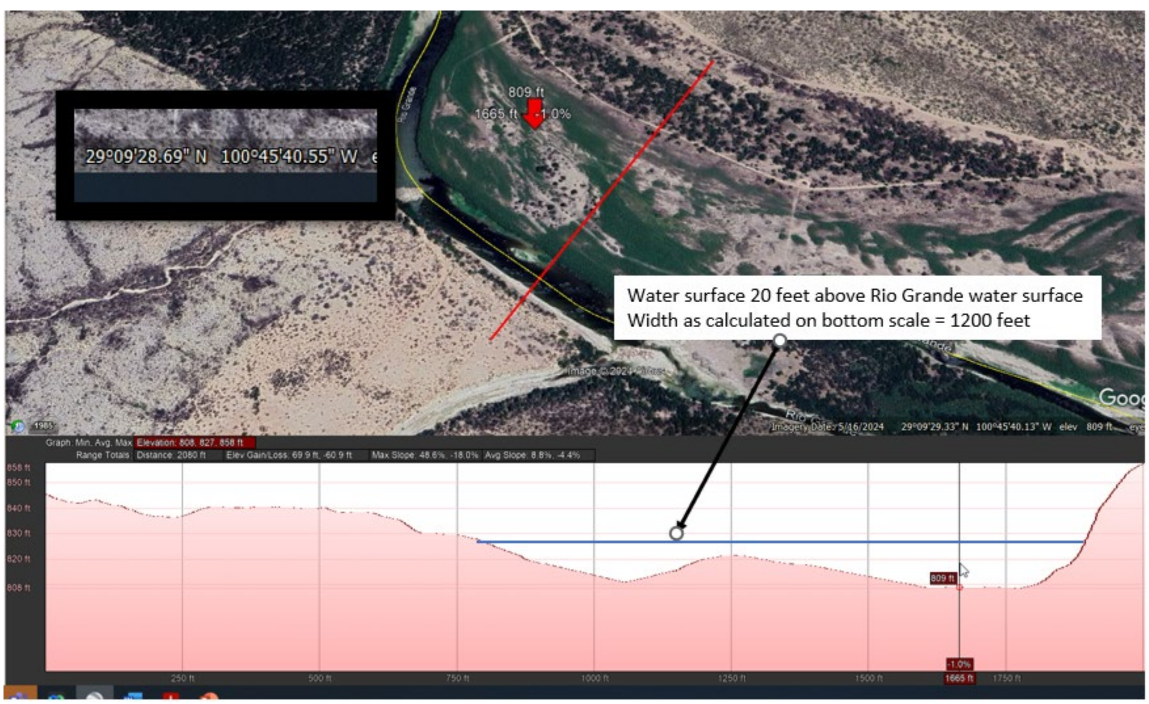
Rock shoal Removal		
Number of removal areas		45
Square feet of each area (130x150)		19500
Depth of removal (feet)		10
volume (cubic yards)		325000
Cost/cubic yard		$ 70.00
	Total Rock Shoals	$ 22,750,000.00
	Total realignment	$ 437,500,000.00
	Total	$ 2,226,839,000.00

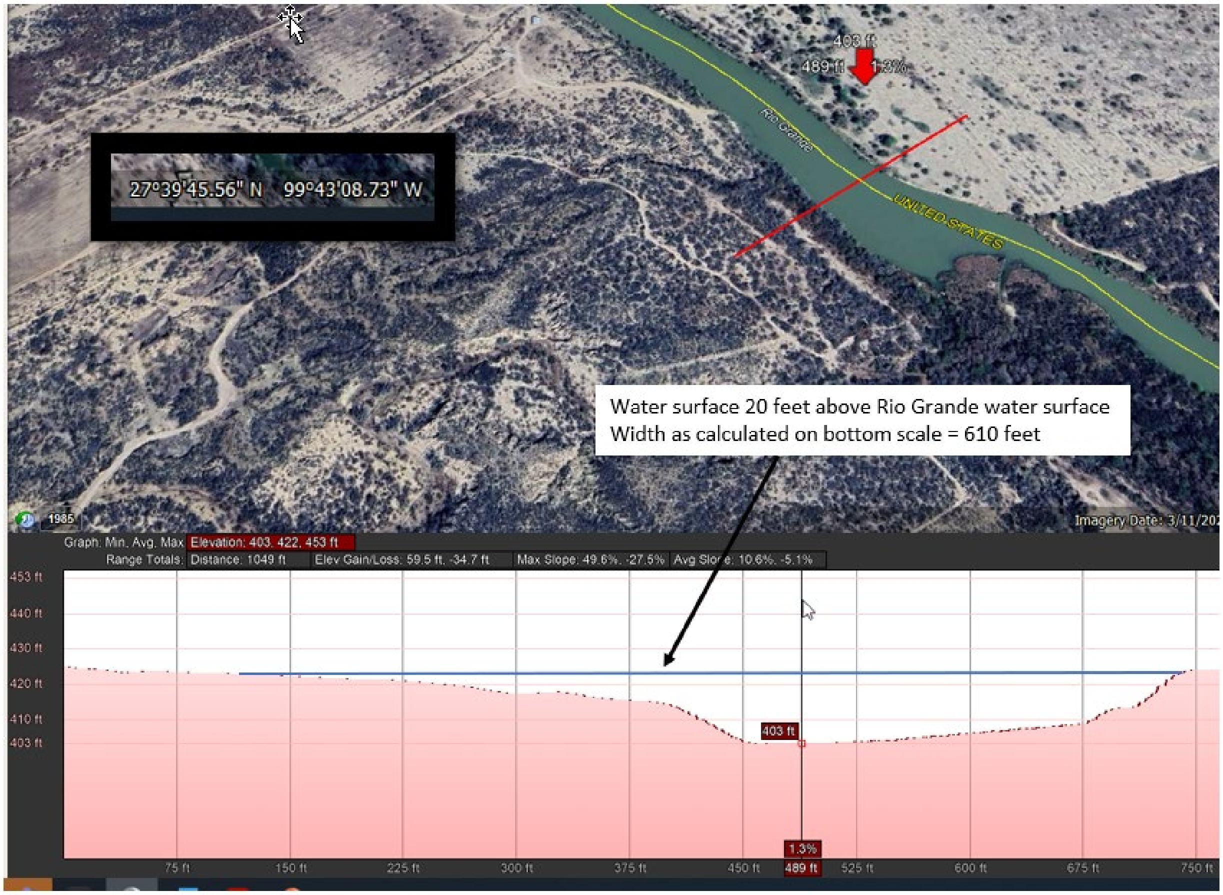
Appendix C: Photo Locations

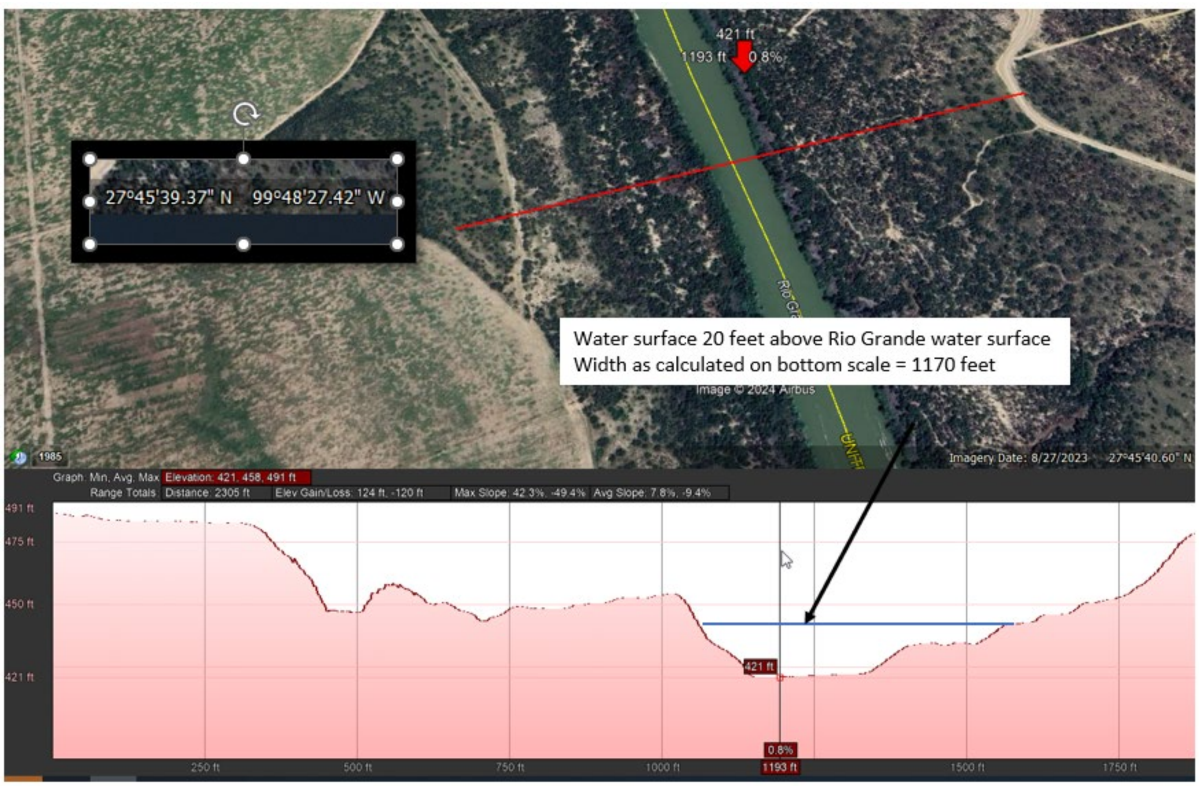


Appendix D: Sample widths immediately above locks and dams as measured in Google Earth






27°39'45.56" N 99°43'08.73" W
Water surface 20 feet above Rio Grande water surface
Width as calculated on bottom scale = 610 feet
Rio Grande
UNITED STATES
Imagery Date: 3/11/202
Graph: Min, Avg, Max Elevation: 403, 422, 453 ft
Range Totals: Distance: 1049 ft Elev Gain/Loss: 59.5 ft, -34.7 ft Max Slope: 49.6%, -27.5% Avg Slope: 10.6%, -5.1%
403 ft
1.3%
489 ft


27°45'39.37" N 99°48'27.42" W
Water surface 20 feet above Rio Grande water surface
Width as calculated on bottom scale = 1170 feet
Image © 2024 Airbus
Imagery Date: 8/27/2023
Graph: Min, Avg, Max Elevation: 421, 458, 491 ft
Range Totals: Distance: 2305 ft Elev Gain/Loss: 124 ft, -120 ft Max Slope: 42.3%, -49.4% Avg Slope: 7.8%, -9.4%
421 ft
0.8%
1193 ft